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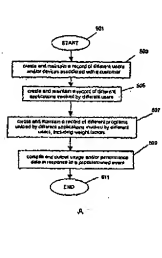
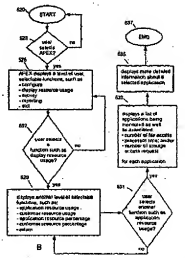
(54) Title: SYSTEM AND METHOD FOR MONITORING COMPUTER APPLICATION AND RESOURCE UTILIZATION



A



B

(57) Abstract: A system and a method for monitoring computer application and resource utilization are presented. In one embodiment, a list of different users associated with different entities or customers of a shared computer is maintained. A second list of different applications invoked by one or more of the different users is also maintained. A third list including different programs employed by the different applications invoked by the different users, including a weighting factor for each program is also maintained. These records are then used to identify operation usage and/or cost characteristics of the different applications by particular users associated with different entities of the shared computer, in response to an event

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System and Method for Monitoring Computer Application and Resource Utilization

Cross Reference to Related Application

This application claims the benefit of a provisional U.S. application, U.S. Serial No. 60/293,685, filed May 25, 2001, in the name of the present inventor.

Field of the Invention

This invention generally relates to monitoring of computer resource usage, and more particularly, to an application expense analysis system and method that allow computer usage to be gathered for various applications including non-batch applications. The present invention may be used, for example, for computer application/customer charge back, and capacity planning.

Background of the Invention

A tool that facilitates computer monitoring has existed for quite some time, such as, for example, the IBM mainframe System Monitoring Facility (SMF) application. Using SMF, for example, resource usage is typically gathered by turning on a monitoring process which collects performance information for all activities on that system. At the end of the day, the records that have been captured are then analyzed and reported on via a batch process. This non-real time data collection is illustrated for example, in Fig. 1. In this prior approach, there is little flexibility in deciding what program is related to which application in a real time basis other than by creating batch reporting jobs at some later time, such as at the end of the day.

Summary of the Invention

The present inventor recognizes that there are several disadvantages to the prior type of performance monitoring applications. First, significant amount of data need to be collected and produced. This is costly to system resources since a CPU is needed to process the data, as well as disk storage

space to store the data. For sites with a high volume of activity, the total amount of CPU time and storage required might be so excessive that this monitoring cannot be used.

This tremendous need for computer resources is illustrated, for example, in Fig. 2 of the present invention. In Fig. 2, estimated numbers of data bytes required for collection and storage for a large, medium and small computer processing site using prior monitoring processes, are shown respectively in column 21, 22 and 23. For example, for a large processing site which runs about a maximum of 45,000 transactions daily, it is estimated that approximately 172.8 million bytes of performance collection data (45,000 transactions x 160 bytes per transactions/hour x 24 hours) need to be processed by CPU and stored in memory, as shown in item 24 of Fig. 2. Therefore, the computer resource drain using prior systems is fairly extensive.

Another drawback of prior systems is that performance results are not immediately apparent and cannot be accessed until the end-of-day when the reporting is completed, and then after all batch processing jobs have been run. This is an inherent problem in the non-real time nature of the prior systems.

Yet another disadvantage of prior systems is that it is difficult to modify the cost model being used for charge back or enhancement. That is, prior systems do not provide information on, for example, what program is associated with what application; or how each program is associated with each application; or which user of a particular customer is using the application or program.

Therefore, one function of present invention is to allow computer resource usage such as CPU and disk activity to be extrapolated across all applications that are sharing a particular computer resource. This helps to solve the problem of needing to identify users of an application so they can be charged for the appropriate costs.

Accordingly, the present invention collects and analyzes performance data in a significantly different manner than the prior systems and methods. For example, although the present invention may use the same collection points provided by an operating system of a computer, but instead of taking the performance data and writing it to disk for the batch process, it quickly categorizes the data in real time through a series of lists, and associates the performance data to a specific application. This results in several advantages not present in prior systems.

One advantage is that since performance collection is ongoing, current results can be accessed immediately. Another advantage is that by having levels of indirection (e.g., program tied to an application group, or known as a service for multiple application groups), the present invention allows easy modification as applications change or new ones are implemented. Yet another advantage is that the present invention allows total costs for collecting to be lessened. For example, by collecting and categorizing results online in real time, the present invention significantly reduce disk storage by not having to save every data record. This in turn results in less CPU time needed to process and report on the captured information.

Therefore, a system and a method for monitoring computer application and resource utilization are presented. In one exemplary embodiment, a list of different users associated with different entities or customers of a shared computer is maintained. A second list of different applications invoked by one or more of the different users is also maintained. A third list including different programs employed by the different applications invoked by the different users, including a weighting factor for each program is also maintained. These records are then used to identify operation usage and/or cost characteristics of the different applications by particular users associated with different entities of the shared computer, in response to an event.

In another exemplary embodiment according to principles of the present invention, a user interface system is described for monitoring individual application utilization of a plurality of concurrently operating applications shared by multiple users associated with one or more entities. A first image is displayed including a user selectable item for selecting display of image data representing processor utilization collated by individual application for a plurality of concurrently operating applications. In response to user selection of the item, a second image is displayed including compiled data identifying at least one of, (a) processor time used by an individual application, (b) a number of file accesses made by an individual application, and (c) a number of storage access requests made by an individual application of said plurality of concurrently operating applications.

Brief Description of the Drawings

In the drawing:

Figure 1 illustrates how a prior system is used to collect performance data.

Figure 2 illustrates the estimated amount of data that are required for different sites using prior systems for collecting data.

Figure 3 illustrates exemplary system and method of data collection according to the principles of the present invention.

Figures 4A and 4B illustrate exemplary lists that may be used in accordance with the present invention.

Figure 5A is a flow diagram of a monitoring process according to the present invention.

Figure 5B shows another flow diagram of the present invention.

Figures 6A to 6E, and 7 to 15 show various user interface screens suitable for use with exemplary system and process according to the present invention.

Detailed Description

The present invention provides an enhanced monitoring process for a computer system. One exemplary implementation of the present invention is Application Expense (APEX) analysis software, to determine application charge back for different customers or entities. An exemplary functional diagram of APEX is shown in Fig. 3.

One advantage of the present invention is the ability to track and associate a given program with a given computer application being invoked in a computer system. An application may be, for example, executable software code in hardwired logic or resident in volatile storage including one or more programs or procedures. An example of a computer application in this regard may be a patient management application for storing and retrieving patient information.

For example, a user may start a patient management application by invoking a patient inquiry screen 303 shown on Fig. 3. Once a patient management application such as request 303 is invoked, various programs associated with the particular application may be called to implement the user request 303. A program in this regard may comprise a program subroutine, a block of computer codes, or a service that is callable by the application being invoked. A program may be dedicated to a particular computer application or shared among many different applications. An example a program includes but is not limited to, for example, a subroutine, a calculation algorithm, a shared service such as a print service, or a paging display, etc.

As shown in Fig. 3, for example, once a user invokes an application 303, various programs 306 - 310 associated with the invoked application 303 may be called by the application 303, as needed. As these programs 306 -

310 are invoked, their use and association to a particular application are tracked by APEX, as shown in Fig. 3.

APEX monitoring process may comprise various sub-processes, as shown in Fig. 3. A first sub-process may be a program analyzer process 310, which creates, maintains and updates various records or lists (e.g., lists 312, 313, 314 and 315) for APEX. These various records or lists contain information to be used by APEX, such as, for example, what statistical data are to be collected, and how to collect them. Another sub-process, a resource collector process 320, collects and correlates various usage and statistical data from the various lists maintained by APEX and output the results for further processing by another sub-process 321 as shown in Fig. 3.

Figures 4A and 4B illustrate exemplary lists or records that may be used by APEX of the present invention. The term record is used herein to signify information or data that is material to a particular subject and that is preserved in non-volatile, permanent or tangible form such as in a computer file, disk, CDROM, DVD etc., or other electronic storage and is accessible by a computer or other electronic processing system.

Lists 412 to 414 shown in Fig. 4A may contain a header/control information field such as field 411 in List 412. Head/control information field 411 generally contains information about what a particular list is used for and access information such as, for example, linked list pointers for improving access performance of a list. For example, header/control information field 411 of Task Activity List (TAL) 412 may contain a pointer to indicate the most-recently or last accessed item in the list.

Besides header/control information field 411, List 412 comprises information about which user, among the shared users of a computer system, has invoked what applications in the system being monitored by APEX. That is, each row in List 412 indicates what applications (e.g., application 1 to application n) have been invoked by the particular user of the row (among

users X of the system). Therefore, APEX is able to assign usage of each application to a particular user of a shared computer system, according to List 412.

Another list, Application/Program List (APL) 413 of Fig. 4A keeps track of which of the different programs have been called by which individual applications of the different applications listed in, for example, List 412. In another aspect of the present invention, each program in List 414 may include an associated "weight" factor, for example, weight factor 415 of Fig. 4A.

A weight factor 415 represents a prediction or an estimate of relative duration of use of a given program by individual applications of the different applications in a computer system. As stated before, a program may be dedicated to only one application or shared among many different applications. Therefore, in one exemplary embodiment, a weight factor may be a number from 1 to 1000, with 1 being the multiply for a program that is shared among many (such as 1000) different applications, and 1000 being a multiplier for a program dedicated to one application. Therefore, the use of a weight factor takes into account of how program resources or costs may be more fairly divided among the different applications in a given computer system. This allows more equitable and accurate customer charge back for computer resource usage, down to detailed program level.

In addition, Buffer field 416 of List 413 improves access time of Application/Program List 413. Buffer field 416 is used to indicate whether a particular row of data record is part of a memory access buffer tracked by Program Buffer Pool List 454 (PBPL) of Fig. 4B to be described below.

By keeping track of a user's association to different applications invoked and a program's association to different applications invoked, Application/Program List 412 in combination with Task Activity List 413, allow APEX to monitor usage and performance of a shared computer system

efficiently. APEX is able to provide detailed and accurate usage and performance data with very little overhead.

Fig. 4 A shows another list, Customer/User List (CUL) 414, which is used to correlate different users and/or devices to different customers or entities that may have access to the system. A customer or an entity of a particular computer system is flexibly defined by APEX. For example, customer 418 shown in List 414 may comprise a company, a corporation, an organization or any other identifiable group of users.

List 414 of Fig. 4A is used to map a device and/or a user to a specific customer of a computer system being monitored by APEX. That is, List 414 is created so that for each customer, all devices and/or users belonging to the particular customer and having access to the computer system are included in this list. A device mask, for example, device mask 419, identifies a device in this list. Device mask 419 is an indicator or ID number identifying a particular device having access to the computer. An example of a device may be a workstation, a computer terminal or other I/O equipment.

Wildcard character function may be used in conjunction with device masks of List 414, so that a group of devices belonging to the same customer may have, for example, the same last 4 characters in order to simplify data input and/or retrieval. List 414, therefore, is able to identify user to customer association and aggregate usage of different users and/or devices on a particular computer system on a per customer basis.

An Application/Cost List (ACL) 451 of Fig. 4B is used to correlate computer resource usage to associated customer and application invoked. The first column 457 of List 451 shows the different applications (each of which is associated with a customer) that have been invoked by a computer system being monitored. For each application invoked, different "criteria stats" 458 and different "performance stats" 459 may be tracked.

Criteria stats 458 are used mainly for APEX self-tuning purposes. That is, for each customer/application being tracked, a system administrator may specify what statistics should be used to track the usage or performance of the customer/application. For example, an administrator may ask APEX to track how many or what user interface screens are generated during the duration of the application so that this information may be used to change weight factors associated with different programs as indicated in Application/Program List 416 of Fig. 4A. These criteria statistics, therefore, may be used to refine the future performance of APEX.

On the other hand, performance stats 459 are actual computer resource statistics that are monitored and used by APEX for, for example, usage charge back purposes. Examples of performance statistics comprise processor time used, number of file access requested, amount of memory (e.g., shared temporary storage) used, etc., for each application invoked.

Other example of records or lists which may be utilized by APEX include Report Generation List (RGL) 452, Application/Statistical Definition List (ASDL) 453, and Program Buffer Pool List (PBPL) 454, as shown in Fig. 4B. Report Generation List 452 contains links to different statistics captured in Application/Cost List 451 described previously. In addition, List 452 may contain information about output reporting criteria (e.g., hourly, daily) and the output mechanism (e.g., via file, SMF, etc.). RGL 452 may be used to correlate and output the collected statistical information based on the information contained in the list.

In addition, Application/Statistical Definition List 453 maps specific statistical reporting criteria to the actual data collection mechanism provided by a computer system being monitored. That is, List 453 translates statistical information provided by the computer system's native operating environment to the APEX specific environment.

Program Buffer Pool List (PBPL) 454 provides a Most-Recently-Used (MRU) pooling construct to keep Application Program List 413 searching to a minimum, as described before in relationship to the buffer field 416 in Application Program List 413. It may also contain other pointers to the Application Program List 413 and Task Activity List 414.

The various records and lists described above are merely exemplary only. They may be implemented in many different ways or forms. For examples, the lists may be created and maintained all in one location or computer file or in different computer files. Also, the lists may be combined or separated in many different ways. For example, Customer/User List 414 shown in Fig. 4A may be implemented via two separate lists, one list associating different users with different customers or entities and another list associating different devices with different users. These two lists may then be used in combination by APEX to identify and track application usage of all the devices and users for a particular customer of the system being monitored.

Fig. 5A shows a flow chart of a monitoring process according to the present invention. At step 503, APEX may dynamically create and maintain a record of different users and/or devices associated with one or more entities or customers of a computer system being monitored. An example of this record may be, for example, Customer/User List 414 shown in Fig. 4A and discussed previously.

At step 505, APEX may dynamically create and maintain a second record. This record may contain association of different applications invoked by each of the different users on the computer system. An example of this record may be Task Activity List 412 as shown in Fig. 4A and discussed above. List 412 keeps track of which users have invoked what applications.

At step 507, APEX may also dynamically create and maintain a third record. This record may contain association of different executable programs employed by the different applications. An example of this record may be

Application Program List 413, shown in Fig. 4A. As discussed before, Application Program List 413 includes a program weight factor for each program being tracked. The use of weight factors supports allocation of proportionate usage of the different programs among the different applications of the system being monitored.

At step 509, APEX in response to a predetermined event, may comply data based on these records, to identify operation usage characteristics of each customer of the shared computer systems, including usage by all the users belonging to a particular customer. The compilation of data may be accomplished by, for example, an APEX resource collector sub-process 320 as shown in Fig. 3, and/or subsequent processes such as process 321 to better analyze and format different collected information. A predetermined event may comprise, and is not limited to an event such as a data access request; a storage access request; termination of use of an individual application; termination of a user operation session; or a periodically generated command.

Fig. 5B shows another flow chart of APEX according to the present invention. As mentioned before, one advantage of the present invention is to allow a user of APEX to easily obtain resource usage information, without having to wait for the end-of-day batch processing. Accordingly, in response to a user requesting APEX at step 523 of Fig. 5B, an exemplary user interface screen 610, as shown in Fig. 6A, is presented to the user by APEX, at step 525. Screen 610 displays a first level of user selectable functions 611 - 615 under APEX for user interaction, as shown in Fig 6A.

At step 527 of Fig. 5B, a user may then select, for example, function 612 "DISPLAY RESOURCE USAGE", of Fig. 6A. At step 529, APEX, in response to this user selection, presents to the user another level of selectable functions 621 to 625 under the display resource usage option category, as shown on screen 620 of Fig. 6B.

At step 531, a user may then select, for example, option 621 "application resource usage", shown on screen 620 of Fig. 6B. This option corresponds to a selection of data representing processor utilization collated by individual application for a plurality of concurrently operating applications. At step 533, once this option 621 is selected, another screen 630 shown in Fig. 6C, will be displayed. Screen 630 comprises a list of applications 631 being tracked by APEX. For each application, APEX may display, for example, processor time used by each associated application within a certain time period, as shown in column 632 of Fig. 6C. APEX also displays total number of file access requests made by each associated application during a time period, as shown in column 633 of Fig. 6C. In addition, APEX display on the same screens 630, a total number of temporary storage (e.g., RAM) access requests 634 made by each application.

Furthermore, at step 535, a user may scroll up and down the list of applications shown in column 631 of screen 630 and selects a particular application to obtain even more detailed statistical information regarding the selected application. For example, Fig. 6E shows exemplary detailed usage and performance information a user may obtain for an application under APEX. These detailed information, may include for example, total number of file read requests 651, and write requests 652, etc.

In addition, Fig. 6D shows screen 640 having application usage information expressed in percentage terms. This screen 640 will be displayed, for example, in response to a user selecting "APPLICATION RESOURCE PERCENTAGE" option 623, shown on screen 620 of Fig. 6B.

Figures 7 to 15 shows other user interface screens according to principles of the present invention. For example, Fig. 14 shows a user interface screen 1401 comprising various options including setup and statistics options for different user reports under APEX. For example, if a user selects option 1402 "REPORT STATUS ACTIVITY" under user screen

1401, APEX may display more detailed information regarding different reports that have been generated in a given time period. For example, APEX may display, within a given time period, the production time of the first report 1502 and the production time of the last report 1503, as shown on screen 1501 of Fig. 15.

It is to be understood that the embodiments and variations shown and described herein are for illustrations only and that various modifications may be implemented by those skilled in the art without departing from the scope of the invention.

What is claimed is:

1. In a system supporting shared access to a plurality of concurrently operating applications by multiple users associated with one or more entities, a method for monitoring individual application utilization, comprising the steps of:

during a time interval,

maintaining a first record of different users associated with an entity;

maintaining a second record of different applications invoked by at least one of said different users;

maintaining a third record of use of an executable program employed by said different applications invoked by said at least one different user, said record of use supporting allocation of proportionate usage of said program between said different applications; and

employing said first, second and third records for intermittently compiling data identifying operation usage characteristics of individual applications of said different applications by particular users associated with said entity in response to a predetermined event.

2. A method according to claim 1, including the step of

allocating usage of said program between said different applications by determining an estimate of relative duration of use of said program by individual applications of said different applications.

3. A method according to claim 2, including the step of

determining and recording weighting factors associated with individual applications of said different applications, said weighting factors representing an estimate of relative duration of use of said program by individual applications of said different applications.

4. A method according to claim 1, wherein said step of compiling data comprises

compiling data identifying at least one of, (a) processor time used by an individual application, (b) a number of file accesses made by an individual application, and (c) a number of storage access requests made by an individual application .

5. A method according to claim 4, wherein said step of compiling data comprises

compiling data supporting identifying relative operation usage characteristics by an individual application as a proportion of said different applications.

6. A method according to claim 1, wherein

said predetermined event comprises at least one of, (a) a data access request, (b) a storage access request, (c) termination of use of an individual application, (d) termination of a user operation session and (e) a periodically generated command.

7. A method according to claim 1, including the step of

maintaining a fourth record associating a processing device with at least one of, (a) a user, (b) an entity and (c) an individual application.

8. A method according to claim 1, wherein

data elements of said second and third records are dynamically created during a session of operation.

9. A method according to claim 1, wherein

said executable program employed by said different applications comprises a program providing a function shared by said different applications.

10. A method according to claim 1, wherein

said entity comprises at least one of, (a) a customer, (b) a company, (c) an organization and (d) an identifiable group of users.

11. A method according to claim 1, including the step of

maintaining a fourth record for use in allocating proportionate usage to an individual application of an executable program shared by a plurality of said different applications.

12. A method according to claim 2, including the step of

allocating proportionate usage of said program between said plurality of said different applications by determining an estimate of relative duration of use of said program by individual applications of said different applications.

13. A method according to claim 1, wherein said step of intermittently compiling data comprises

intermittently compiling data identifying at least one of, (a) size of storage employed by an individual application, (b) a number of input/output requests made by an individual application, (c) a number of file deletion requests made by an individual application and (d) storage size employed for user data.

14. A user interface system for monitoring individual application utilization of a plurality of concurrently operating applications shared by multiple users associated with one or more entities, comprising the steps of:

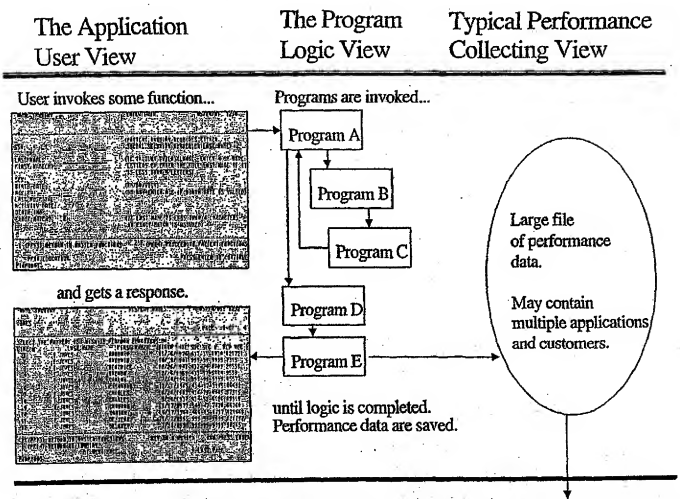
initiating display of a first image including a user selectable item for selecting display of image data representing processor utilization collated by individual application for a plurality of concurrently operating applications; and

in response to user selection of said item,

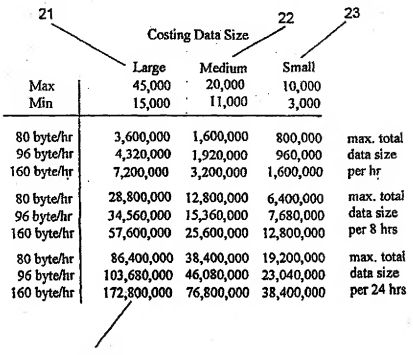
initiating display of a second image including compiled data identifying at least one of, (a) processor time used by an individual application, (b) a number of file accesses made by an individual application, and (c) a number of storage access requests made by an individual application of said plurality of concurrently operating applications.

15. A method according to claim 19, including the step of

deriving said compiled data by intermittently generating data identifying operation usage characteristics of individual applications of said plurality of concurrently operating applications based on accumulated operation data records, said operation usage characteristics being collated for individual users associated with an entity.



Prior Art
Fig. 1



Prior Art

Fig. 2

Notes:

1. large sample was not for a super large customer or entity
2. 80 bytes provided CPU statistic only
3. 96 bytes provided CPU, file, TS (temporary storage) etc. overviews
4. 160 bytes provided CPU and detailed fields
5. using all CMF fields would require 350+ bytes

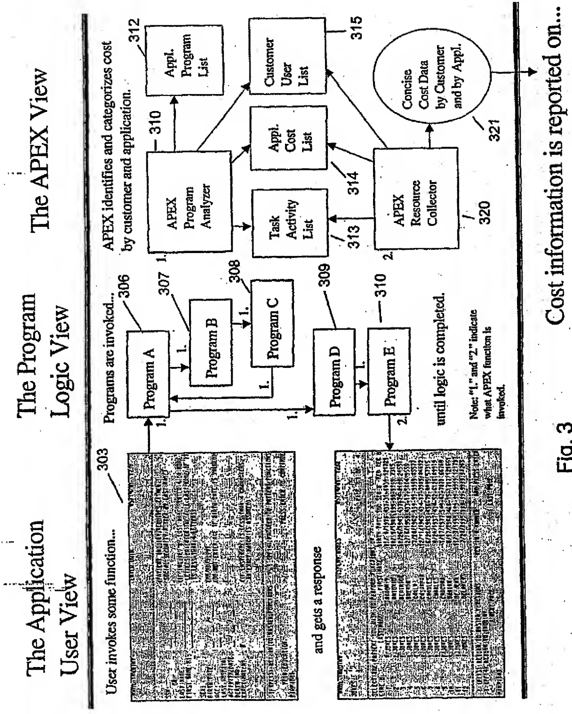

The Application User View
The Program Logic View
The APEX View
User invokes some function...
303
and gets a response
Programs are invoked...
306
307
308
309
310
Program A
Program B
Program C
Program D
Program E
1.
2.
until logic is completed.
Note: "1." and "2." indicate what APEX function is invoked.
APEX identifies and categorizes cost by customer and application.
APEX Program Analyzer
310
Appl. Program List
312
Task Activity List
313
Appl. Cost List
314
Customer User List
315
APEX Resource Collector
320
Concise Cost Data by Customer and by Appl.
321
Cost information is reported on...

Fig. 3

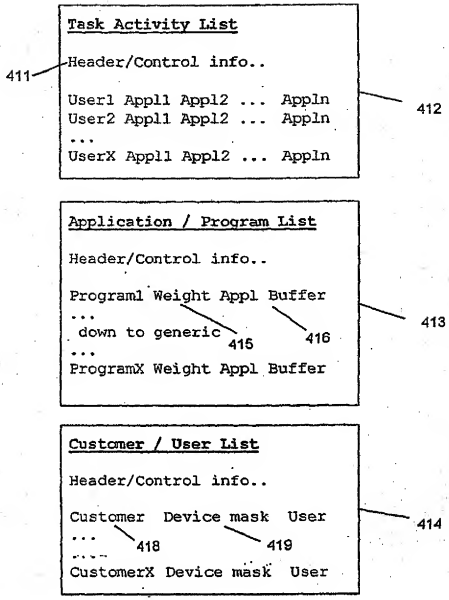

Task Activity List
Header/Control info..
User1 Appl1 Appl2 ... Appln
User2 Appl1 Appl2 ... Appln
...
UserX Appl1 Appl2 ... Appln
411
412
Application / Program List
Header/Control info..
Program1 Weight Appl Buffer
...
down to generic
...
ProgramX Weight Appl Buffer
415
416
413
Customer / User List
Header/Control info..
Customer Device mask User
...
CustomerX Device mask User
418
419
414

Fig. 4A

Application / Cost List

Header/Control info..

457	458	459
Cust1/Appl1	Criteria Stats	Performance Stats
Cust1/Appl2	Criteria Stats	Performance Stats
...		
Cust1/Appln	Criteria Stats	Performance Stats
...		
CustX/Appln	Criteria Stats	Performance Stats

451

Report Generation List

Links to statistics captured in the ACL.
Followed by reporting criteria (hourly, daily) and the output mechanism (file, SMF etc..)

452

Application / Statistical Definition List

Maps specific statistical reporting criteria to the actual data collection mechanism provided by the online system.

453

Program Buffer Pool

Provides an MRU pooling construct to keep APL list searching to a minimum. Has pointers to the APL and TAL constructs.

454

Fig. 4B

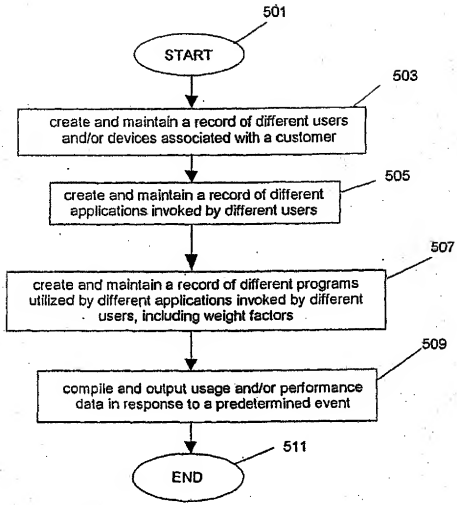

501
START
503
create and maintain a record of different users and/or devices associated with a customer
505
create and maintain a record of different applications invoked by different users
507
create and maintain a record of different programs utilized by different applications invoked by different users, including weight factors
509
compile and output usage and/or performance data in response to a predetermined event
511
END

Fig. 5A

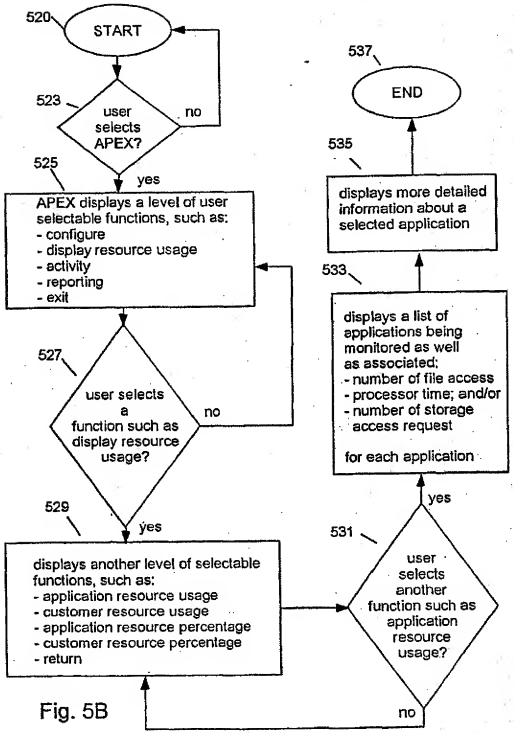

520
START
523
user selects APEX?
no
yes
525
APEX displays a level of user selectable functions, such as:
- configure
- display resource usage
- activity
- reporting
- exit
527
user selects a function such as display resource usage?
no
yes
529
displays another level of selectable functions, such as:
- application resource usage
- customer resource usage
- application resource percentage
- customer resource percentage
- return
531
user selects another function such as application resource usage?
yes
no
533
displays a list of applications being monitored as well as associated:
- number of file access
- processor time; and/or
- number of storage access request
for each application
535
displays more detailed information about a selected application
537
END

Fig. 5B

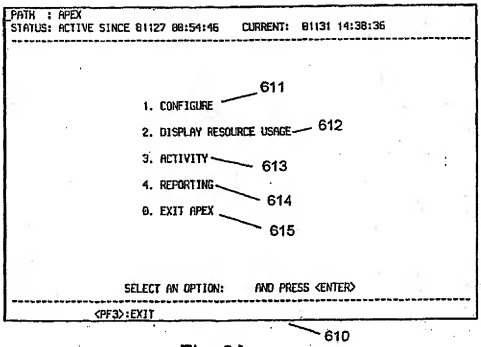

PATH : APEX
STATUS: ACTIVE SINCE 01127 00:54:46 CURRENT: 01131 14:38:36
1. CONFIGURE
2. DISPLAY RESOURCE USAGE
3. ACTIVITY
4. REPORTING
0. EXIT APEX
611
612
613
614
615
SELECT AN OPTION: AND PRESS <ENTER>
<PF3>:EXIT
610

Fig. 6A

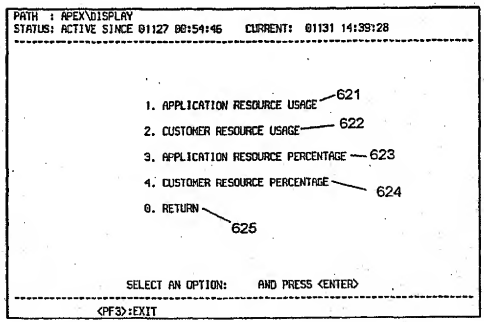

PATH : APEX\DISPLAY
STATUS: ACTIVE SINCE 01127 00:54:46 CURRENT: 01131 14:39:28
1. APPLICATION RESOURCE USAGE
2. CUSTOMER RESOURCE USAGE
3. APPLICATION RESOURCE PERCENTAGE
4. CUSTOMER RESOURCE PERCENTAGE
0. RETURN
621
622
623
624
625
SELECT AN OPTION: AND PRESS <ENTER>
<PF3>:EXIT
620

Fig. 6B

PATH : APEX\DISPLAY\APPLICATION_RESOURCE_USAGE
STATUS: ACTIVE SINCE 01127 00:54:46 CURRENT: 01131 14:40:28

APPLICATION	TOTAL CPU TIME	TOTAL FILE REQUESTS	TOTAL TS REQUESTS
APS	00:00:00.00000	0	0
BNS	00:00:00.00000	0	0
CHT	00:00:00.00000	0	0
CIC	00:00:01.37152	3,595	5,213
CMA	00:00:00.00445	7	4
CMF	00:00:00.00000	0	0
CRM	00:00:00.22600	1,434	305
CWS	00:00:00.01048	32	11
GDI	00:00:00.00000	272	186
GLS	00:00:00.00000	0	0
HRS	00:00:00.00000	0	0
IBS	00:00:00.00000	0	0
MML	00:00:01.70035	1,837	951
MRS	00:00:00.04868	124	16
NDB	00:00:00.01678	52	4
MORE->			
TOTALS	00:00:16.73048	69,482	18,750

<PF3>:RETURN <PF5>:VIEW % <PF8>:DOWN SELECT FOR DETAILS

637 631 632 633 634 630

Fig. 6C

PATH : APEX\DISPLAY\APPLICATION_RESOURCE_BY_%
STATUS: ACTIVE SINCE 01127 00:54:46 CURRENT: 01131 14:40:44

APPLICATION	TOTAL CPU TIME	TOTAL FILE REQUESTS	TOTAL TS REQUESTS
APS			
BNS			
CHT			
CIC	08.15%	05.16%	27.69%
CMA	00.02%	00.01%	00.02%
CMF			
CRM	01.34%	02.05%	01.62%
CWS	00.06%	00.04%	00.05%
GDI	00.54%	00.39%	00.56%
GLS			
HRS			
IBS			
MML	10.14%	01.49%	05.07%
MRS	00.28%	00.17%	00.08%
NDB	00.09%	00.07%	00.02%
MORE->			
TOTALS	100.00%	100.00%	100.00%

<PF3>:RETURN <PF5>:VIEW # <PF8>:DOWN SELECT FOR DETAILS

640

Fig. 6D

```
PATH  : APEX\DISPLAY\APPLICATION_RESOURCE_USAGE
STATUS: ACTIVE SINCE 01127 00:54:46   CURRENT:  01131 14:41:40

NHRA CODE: L0NU                       APPLICATION:  CIC

STATISTIC                  VALUE      STATISTIC                  VALUE
-------------------------------------------------------------------------
TTL ALLOC REQ.             3,663      MAX USER  STG USED       133,264
MAX USER  STG USED        53,632      MAX CDSA STG USED          5,664
MAX ECDSA STG USED         6,328      MAX PGM STG (TTL)        510,152
MAX 16M+ PGMSTG USED     484,496      MAX 16M- PGMSTG USED     118,936
FILE READ REQUESTS         2,010      FILE WRITE REQUESTS           90
FILE BROWSE REQUESTS         256      FILE ADD REQUESTS            745
FILE DELETE REQUESTS         188      TOTAL FILE REQUESTS        3,687
TOTAL FILE ACC.I/F         4,339      TOTAL TD REQUESTS          1,473
TS GET REQUESTS            3,036      TS-AUX PUT REQUESTS        2,218
TS-MAIN PUT REQUESTS           8      TOTAL TS REQUESTS          5,246
PROGRAM LINK REQ.          3,187      PROGRAM XCTL REQ.            109
JOURNAL OUTPUT REQ.          110      TTL DISP TIME     00:00:04.34664
TOTAL CPU TIME    00:00:01.46385      TTL SUSP TIME     00:00:55.66921
T TERM I/O WTIME  00:00:14.53320      TTL FI I/O WTIME  00:00:11.71616
TTL JC I/O WTIME  00:00:00.96356      TTL TS I/O WTIME  00:00:00.20697
-------------------------------------------------------------------------
            <PF3>:EXIT
```

651 652 650

Fig. 6E

```
PATH  : APEX\ACTIVITY
STATUS: ACTIVE SINCE 01127 00:54:46   CURRENT:  01131 14:43:48
-------------------------------------------------------------------------

                    1. PROGRAM-APPLICATION MASK LIST

                    2. CURRENT TASK-ACTIVITY

                    3. LAST ACTIVE... (PGMS,TRNS,TSKS)

                    4. APPLICATION ACTIVITY STATISTICS

                    5. MISCELLANEOUS

                    8. RETURN


                  SELECT AN OPTION:  3  AND PRESS <ENTER>
-------------------------------------------------------------------------
            <PF3>:EXIT
```

Fig. 7

PATH : APEX\ACTIVITY\PROGRAM-APPLICATION_MASK_LIST
STATUS: ACTIVE SINCE 01127 00:54:46 CURRENT: 01131 14:44:16

TOTAL REFERENCES : 3,486,617 PAGE : 1

PROGRAM / APPL	COUNT	WT	PROGRAM / APPL	COUNT	WT
A2000PCL MRS	33,948	80	A2000PHP IBS	0	80
A2000TCL NSS	0	80	A2003TMF IBS	0	80
A2000TRV URS	0	80	GAN#RASW PAS	0	80
REPTSIGN SCH	170	80	SNSWNDBE NDB	0	1
A2000L7X OPS	0	80	A2000N7W OPS	0	80
A2000P7X OPS	0	80	A2000P7W OPS	0	80
A2000TXX RXS	0	80	PETPARSX PET	0	80
BCFXxxxx CIC	0	80	CDQxxxxx EAD	0	80
CIXxxxxx NDB	8,162	1	DFHxxxxx CIC	41,377	1
DRGXxxxx CNA	0	80	GAAxxxxx APS	0	80
GAFXxxxx PAM	0	80	GAHxxxxx HRS	0	80
GAXXxxxx PAS	0	80	HDDxxxxx EAD	0	80
MASXxxxx PNS	0	80	NDExxxxx NDB	120,362	1
OIDxxxxx EAD	0	80	PDFxxxxx OAS	0	10
PFDxxxxx PMS	1,253	80	PQDxxxxx HRS	0	80

<PF3>:EXIT <PF8>:DOWN

Fig. 8

PATH : APEX\ACTIVITY\LAST_ACTIVE\PROGRAMS
STATUS: ACTIVE SINCE 01127 00:54:46 CURRENT: 01131 14:44:45

LAST 100 REFERENCES

1-CHPPPGB1	2-CHPPPGB1	3-CHPPPGB1	4-CHPPPGB1	5-CHPPPGB1	6-CHPPPGB1
7-CHPPPGB1	8-CHPPPGB1	9-PA201100	10-PA201100	11-CHPPPGB1	12-CHPPPAGE
13-CHPPMAIN	14-CIACZDSL	15-CITMFATD	16-DFHZCQ	17-DFHZATD	18-CIMKROUT
19-CINEPRCO	20-CISISERV	21-CISISERV	22-CISISERV	23-CISISERV	24-CICDJASU
25-CIXVSIGN	26-CINEPSMS	27-DFHZNEP	28-DFHSFP	29-CIFPLOGO	30-CHPPPGB1
31-CHPPPAGE	32-CHPPPGB1	33-CHPPPGB1	34-CHPPPGB1	35-NDBLDPC	36-CHPPAPID
37-CHPPMAIN	38-CISMSMAS	39-CIFPUCON	40-CHPPSIOF	41-CIMKROUT	42-CHPPXENQ
43-CHPPXENQ	44-CHPPSYLG	45-CIFPUCON	46-CHPPSYSO	47-CHPPSION	48-CHPPPGB1
49-CHPPPGB1	50-CHPPPGB1	51-CHPPPGB1	52-CHPPPGB1	53-CHPPPGB1	54-CHPPPGB1
55-CHPPPGB1	56-PA201100	57-PA201100	58-CHPPMAIN	59-CHPPSYCP	60-CHPPSYCP
61-CHPPPGB1	62-CHPPPGB1	63-CICSAUTH	64-CHPPCWAC	65-CHPPGTNN	66-PA200000
67-CICSAUTH	68-CHPPCWAC	69-CHPPGTNN	70-PA201000	71-CHPPMAIN	72-CHPPCCON
73-CHPPSYSO	74-CHPPSION	75-CHPPMAIN	76-CHPPMAIN	77-CHPPMAIN	78-CHPPPGB1
79-CHPPPGB1	80-CHPPPGB1	81-CHPPPGB1	82-CHPPPGB1	83-CHPPPGB1	84-CHPPPGB1
85-CHPPPGB1	86-PA201100	87-PA201400	88-CHPPMAIN	89-CHPPSYCP	90-CHPPMAIN
91-CHPPCCON	92-CHPPSION	93-CHPPMAIN	94-CIFPUCON	95-CHPPCOB1	96-CIMKROUT
97-CHPPXENQ	98-CHPPXENQ	99-CHPPSYLG	100-NDBLDPC		

<PF3>:EXIT <PF5>:VIEW TASK/TRAN

Fig. 9

PATH : APEX\ACTIVITY\APPLICATION_ACTIVITY_STATISTICS
STATUS: ACTIVE SINCE 01127 00:54:46 CURRENT: 01131 14:45:06

RECS PROCSD/TOTAL: 383,008 / 387,452 CLOSE WEIGHT: 2

APPLICATION	TOTAL	SWEEP	CLOSE	APPLICATION	TOTAL	SWEEP	CLOSE
L0NU-APS	2,117	0	0	L0NU-BNS	0	0	0
L0NU-CHT	0	0	0	L0NU-CIC	76,015	0	1,946
L0NU-CMA	70	0	0	L0NU-CNF	0	0	0
L0NU-CRM	2,707	12	0	L0NU-CNS	377	377	377
L0NU-GDI	6,252	9	1	L0NU-GLS	886	166	1
L0NU-HRS	0	0	0	L0NU-IBS	0	0	0
L0NU-MML	19,285	5,693	1,984	L0NU-MRS	484	56	6
L0NU-NDB	118	7	78	L0NU-NSS	0	0	0
L0NU-OAS	148,644	4,092	67,794	L0NU-OPS	17,585	17,585	175
L0NU-PAM	0	0	0	L0NU-PAS	46,624	46,622	17,633
L0NU-PET	0	0	0	L0NU-PMS	59,484	59,477	1,789
L0NU-RDC	0	0	0	L0NU-RRS	0	0	0
L0NU-RSS	241	241	0	L0NU-RXS	2,051	2,051	1,182
L0NU-SCH	212	212	121	L0NU-URS	2	2	0
L0NU-EAD	0	0	0	L0NU-UKN	14	1	0

<PF3>:EXIT <PF5>:VIEW PATH LENGTH

Fig. 10

PATH : APEX\ACTIVITY\APPLICATION_ACTIVITY_STATISTICS
STATUS: ACTIVE SINCE 01127 00:54:46 CURRENT: 01131 14:45:39

RECS PROCSD/TOTAL: 383,852 / 387,496 CLOSE WEIGHT: 2

APPLICATION	AVG.	MIN.	MAX.	APPLICATION	AVG.	MIN.	MAX.
L0NU-APS	12.5	2	1,887	L0NU-BNS	0.0	0	0
L0NU-CHT	0.0	0	0	L0NU-CIC	3.3	1	1,870
L0NU-CMA	15.0	4	447	L0NU-CNF	0.0	0	0
L0NU-CRM	38.3	2	446	L0NU-CNS	5.0	4	7
L0NU-GDI	14.0	1	42	L0NU-GLS	19.9	2	248
L0NU-HRS	0.0	0	0	L0NU-IBS	0.0	0	0
L0NU-MML	7.6	1	218	L0NU-MRS	84.7	3	276
L0NU-NDB	33.4	1	758	L0NU-NSS	0.0	0	0
L0NU-OAS	28.7	1	2,928	L0NU-OPS	14.5	2	315
L0NU-PAM	0.0	0	0	L0NU-PAS	12.4	1	156
L0NU-PET	0.0	0	0	L0NU-PMS	13.8	1	3,165
L0NU-RDC	0.0	0	0	L0NU-RRS	0.0	0	0
L0NU-RSS	5.0	5	6	L0NU-RXS	7.2	2	42
L0NU-SCH	2.8	2	35	L0NU-URS	14.0	11	17
L0NU-EAD	0.0	0	0	L0NU-UKN	1.8	1	2

<PF3>:EXIT <PF5>:VIEW STATISTICS

Fig. 11

```
PATH  : APEX\ACTIVITY\MISCELLANEOUS
STATUS: ACTIVE SINCE 01127 00:54:46    CURRENT:  01131 14:46:02
-------------------------------------------------------------------------------

                        1. BUFFER STATISTICS

                        *. MULTI-CLIENT ACTIVITY

                        0. RETURN

                    SELECT AN OPTION:     AND PRESS <ENTER>
-------------------------------------------------------------------------------
              <PF3>:EXIT
```

Fig. 12

```
PATH  : APEX\ACTIVITY\MISCELLANEOUS\BUFFER_STATISTICS
STATUS: ACTIVE SINCE 01127 00:54:46    CURRENT:  01131 14:46:33

BUFFERS:          21    TTL HITS:    2,837,723   TTL ADDS:      650,544

HIT-PGM  RULEBASE  TTL-HITS  TTL-REFS  HIT-PGM  RULEBASE  TTL-HITS  TTL-REFS
-------------------------------------------------------------------------------
CHPPSYCP     MISC   485,333   738,621  CIACZDSM CIxxxxxx   191,492   259,191
CHPPMAIN CHPPMAIN   234,559   239,925  PA201100 PAxxxxxx    79,245   118,826
CHPPCCON     MISC   485,333   738,621  PA201400 PAxxxxxx    79,245   118,826
CHPPSION     MISC   485,333   739,621  CICSAUTH CIxxxxxx   191,492   259,191
CHPPPG01 CHPPPG01   301,420   307,361  PA201800 PAxxxxxx    79,245   118,826
CHPPCMAC CHPPCMAC   215,365   220,529  PA200000 PAxxxxxx    79,245   118,826
CHPPGTNN CHPPGTNN   104,494   114,022  CIFPUCOF CIxxxxxx   191,492   259,191
CHPPPAGE CHPPPAGE    60,752    67,194  PA221700 PAxxxxxx    79,245   118,826
CHPPCSUP     MISC   485,333   738,621  DFHEAMN  DFHxxxxx    18,519    41,438
CHPPTIME     MISC   485,333   738,621  CISISERV CIxxxxxx   191,492   259,191
CHPPNNIM CHPPNNIM      488     3,829  CIFPUTSI CIxxxxxx   191,492   259,191
CHPPNNEH CHPPNNEH      398     3,794  CIFPGMN  CIxxxxxx   191,492   259,191
CHPPOP50 CHPPOPxx   21,374    45,802  CIONCSAC CIxxxxxx   191,492   259,191
CHPPOP10 CHPPOPxx   21,374    45,802  CIXVSIGN CIXxxxxx     3,688     8,176
CHPPXENQ CHPPXENQ   408,190   413,554  CIMMROUT CIxxxxxx   191,492   259,191
-------------------------------------------------------------------------------
              <PF3>:EXIT
```

Fig. 13

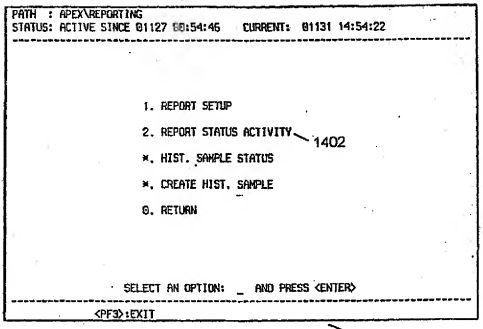

PATH : APEX\REPORTING
STATUS: ACTIVE SINCE 01127 00:54:46 CURRENT: 01131 14:54:22
1. REPORT SETUP
2. REPORT STATUS ACTIVITY
*. HIST. SAMPLE STATUS
*. CREATE HIST. SAMPLE
0. RETURN
SELECT AN OPTION: _ AND PRESS <ENTER>
<PF3>:EXIT
1402
1401

Fig. 14

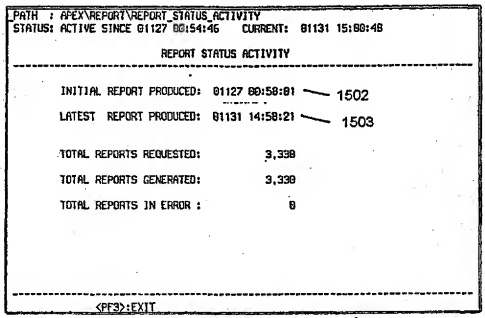

PATH : APEX\REPORT\REPORT_STATUS_ACTIVITY
STATUS: ACTIVE SINCE 01127 00:54:46 CURRENT: 01131 15:00:48
REPORT STATUS ACTIVITY
INITIAL REPORT PRODUCED: 01127 00:58:01
LATEST REPORT PRODUCED: 01131 14:58:21
TOTAL REPORTS REQUESTED: 3,330
TOTAL REPORTS GENERATED: 3,330
TOTAL REPORTS IN ERROR : 0
<PF3>:EXIT
1502
1503
1501

Fig. 15

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

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PCT

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(25) Filing Language: English

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(74) Agents: BURKE, Alexander, J. et al.; Siemens Corporation, Intellectual Property Dept., 186 Wood Ave. South, Iselin, NJ 08830 (US).

(81) Designated States *(national)*: CA, JP.

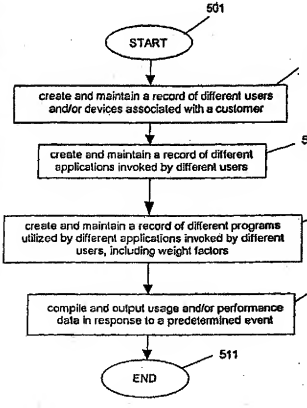
(84) Designated States *(regional)*: European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR).

Published:
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

(88) Date of publication of the international search report:
1 April 2004

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: SYSTEM AND METHOD FOR MONITORING COMPUTER APPLICATION AND RESOURCE UTILIZATION



(57) Abstract: A system and a method for monitoring computer application and resource utilization are presented. In one embodiment, a list of different users associated with different entities or customers of a shared computer is maintained. A second list of different applications invoked by one or more of the different users is also maintained. A third list including different programs employed by the different applications invoked by the different users, including a weighting factor for each program is also maintained. These records are then used to identify operation usage and/or cost characteristics of the different applications by particular users associated with different entities of the shared computer, in response to an event

WO 2002/097630 A3

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 02/15485

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G06F11/34

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G06F H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, INSPEC, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	"AIX VERSION 3.2 - SYSTEM MANAGEMENT GUIDE: OPERATING SYSTEM AND DEVICES, CHAPTER 14 SYSTEM ACCOUNTING" SYSTEM MANAGEMENT GUIDE: OPERATING SYSTEM AND DEVICES, 1 October 1993 (1993-10-01), pages 14-1-14-29, XP002067192 abstract pages 14-1 pages 14-2, line 17 - line 28 pages 14-3, line 34 - pages 14-4, line 31 pages 14-5, line 21 - line 28 pages 14-6, line 19 - line 20 pages 14-19 ----- -/--	1-13,15

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 September 2003	20.01.2004
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Sabbah, Y

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 02/15485

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 501 076 A (IBM) 2 September 1992 (1992-09-02) abstract column 4, line 2 - line 9 column 4, line 42 - line 46 column 5, line 24 - line 49 column 6, line 10 - line 52 column 9, line 32 - line 40 column 11, line 2 - line 35 figures.1-3	1-13,15
A	US 4 481 583 A (MUELLER MARK W) 6 November 1984 (1984-11-06) abstract column 2, line 17 - line 28 column 3 column 7, line 20 - line 25 column 7, line 47 - line 51 figure 1	1-3,11, 12

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

International application No.
PCT/US 02/15485

INTERNATIONAL SEARCH REPORT

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-13,15

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-13,15

   A method to monitor the resource usage of several applications shared by multiple users

2. claim: 14

   A user interface displaying resource usage information

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 02/15485

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